TIMCO ENGINEERING, Inc.

An IIA Company

FCC CFR 47 Part 2.1091

RF Exposure / MPE Report

APPLICANT	CODAN RADIO COMMUNICATIONS
FCC	H4JCASC165B
MODEL NUMBER	CASC-TR-01-165
PRODUCT DESCRIPTION	RADIO TRANSCEIVER WITH POWER AMPLIFIER
DATE SAMPLE RECEIVED	12/2/2019
FINAL TEST DATE	12/13/2019
REPORT NUMBER	3273AUT19_FCC MPE Report_

AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION
UNDER ISO/IEC 17025, AND ISO/IEC 17065

ACCREDITED
Certificate #0955.01

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SIGNATURE PAGE

Timco Engineering, Inc. attests that:

This report relates only to the Equipment Under Test (EUT) sample(s) tested.

This report shall not be reproduced except in full without the written approval of Timco Engineering, Inc.

To the best of my knowledge and belief, this device has been tested in accordance with the standards identified in this test report, and these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025 requirements.

I attest that measurements were made at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669

Name and Title Franklin Rose, Project Manager / EMC Specialist

Name and Title Tim Royer, Project Manager / EMC Engineer

Name and Title Sharon Hoffman, Senior Marketing Director

Date 12/13/2019

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TESTING LABORATORY

Timco Engineering Inc.
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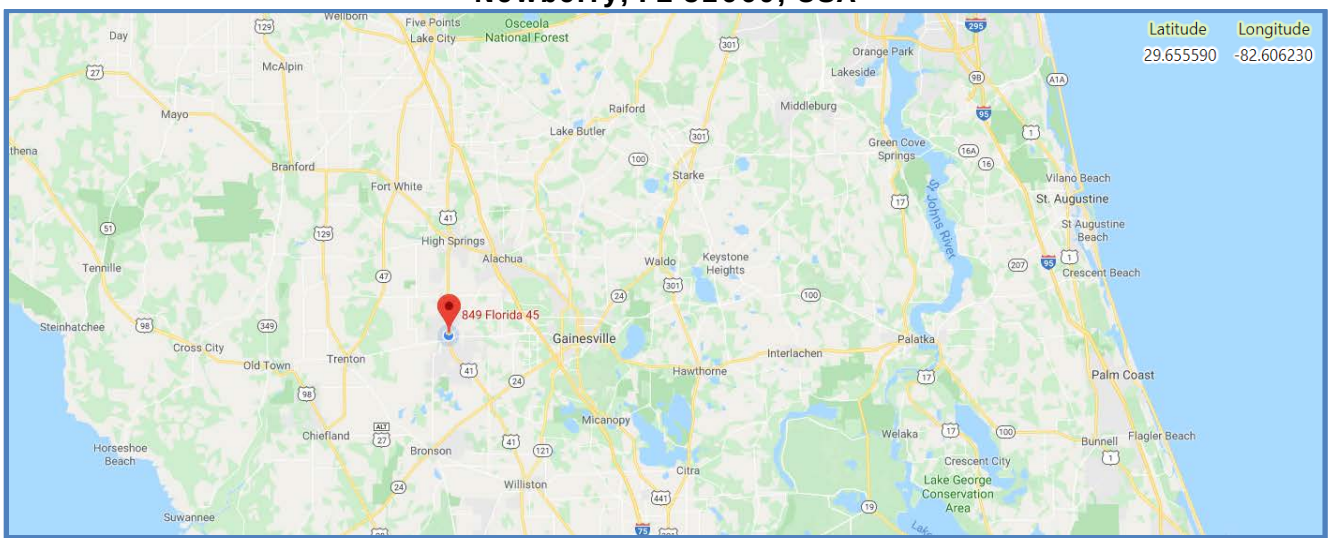
Newberry, FL 32669, USA



United States	FCC Accredited and Recognized Test Lab & TCB # US1070
	DHS Recognized P25 CAP Test Facility # P25CAPTIMCO081016
Australia / New Zealand	U.S. CABs Recognized by Australia ACMA Under MRA
Canada	U.S. Lab & CB Recognized by Canada ISED, Designation # US0111, Test Site # 2056A
Chinese Taipei	U.S. CABs Recognized by Chinese Taipei BSMI/NCC Under MRA
European Union	U.S. EMC & RE Directive NB's, Designation # US0111, Notified Body # 1177
Hong Kong	U.S. Labs & CBs Recognized by Hong Kong OFCA Under MRA
Israel	U.S. CABs Recognized by Israel MOE/MOC Under MRA
Japan	U.S. RCBs Recognized by Japan MIC
Korea	U.S. CABs Recognized by Korea RRA Under MRA
Mexico	U.S. CABs Recognized by Mexico IFT Under MRA
Singapore	U.S. Labs & CBs Recognized by Singapore IMDA Under MRA
Vietnam	U.S. CABs Recognized by Vietnam MIC Under MRA

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TEST INFORMATION

Report Version	Description	Issue Date
Rev1	Initial Issue	12/13/2019
Rev2	Revised Calculation	02/18/2020
Rev3		
Rev4		
Rev5		
Rev6		

Test Conditions	Temperature during testing: 26ºC, Humidity during testing: 50%
Test Exercise	The EUT was operated in accordance with the service manual using software supplied by the manufacturer.
Applicable Standards	FCC CFR 47 Part 2, Jan 2020 FCC CFR 47 Part 1, Jan 2020
Test Facility	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA

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EUT INFORMATION

EUT Description	RADIO TRANSCEIVER WITH POWER AMPLIFIER		
Model Number	CASC-TR-01-165		
Modified for Testing	☐		
Modification	n/a		
Antenna Connector	☐ UHF	☐ BNC	☒ N
	☐ TNC	☐ SMA	☐ Other
EUT Power Source	☐ AC Power (110-120 V)	☒ DC Power (48 V)	☐ DC Battery (7.4 V)
Test Item	☐ Engineering Prototype	☒ Pre-Production	☐ Post-Production
Type of Equipment	☒ Fixed	☐ Mobile	☐ Portable

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FCC PT 1.1310 SAR & MPE

☐ (a) Specific absorption rate (SAR) shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b) within the frequency range of 100 kHz to 6 GHz (inclusive).

☐ (b) The SAR limits for occupational/controlled exposure are 0.4 W/kg, as averaged over the whole body, and a peak spatial-average SAR of 8 W/kg, averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the parts of the human body treated as extremities, such as hands, wrists, feet, ankles, and pinnae, where the peak spatial-average SAR limit for occupational/controlled exposure is 20 W/kg, averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). Exposure may be averaged over a time period not to exceed 6 minutes to determine compliance with occupational/controlled SAR limits.

☐ (c) The SAR limits for general population/uncontrolled exposure are 0.08 W/kg, as averaged over the whole body, and a peak spatial-average SAR of 1.6 W/kg, averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the parts of the human body treated as extremities, such as hands, wrists, feet, ankles, and pinnae, where the peak spatial-average SAR limit is 4 W/kg, averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). Exposure may be averaged over a time period not to exceed 30 minutes to determine compliance with general population/uncontrolled SAR limits.

☒ (d)(1) Evaluation with respect to the SAR limits in this section and in §2.1093 of this chapter must demonstrate compliance with both the whole-body and peak spatial-average limits using technically supportable methods and exposure conditions in advance of authorization (licensing or equipment certification) and in a manner that permits independent assessment.

☒ (2) At operating frequencies less than or equal to 6 GHz, the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 of paragraph (e) of this section, may be used instead of whole-body SAR limits as set forth in paragraph (a) through (c) of this section to evaluate the environmental impact of human exposure to RF radiation as specified in §1.1307(b), except for portable devices as defined in §2.1093 as these evaluations shall be performed according to the SAR provisions in §2.1093 of this chapter.

☐ (3) At operating frequencies above 6 GHz, the MPE limits shall be used in all cases to evaluate the environmental impact of human exposure to RF radiation as specified in §1.1307(b).

☐ (4) Both the MPE limits listed in Table 1 of paragraph (e) of this section and the SAR limits as set forth in paragraph (a) through (c) of this section and in §2.1093 of this chapter are for continuous exposure, that is, for indefinite time periods. Exposure levels higher than the limits are permitted for shorter exposure times, as long as the average exposure over the specified averaging time in Table 1 is less than the limits. Detailed information on our policies regarding procedures for evaluating compliance with all of these exposure limits can be found in the FCC's *OET Bulletin 65,* "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields," and in supplements to *Bulletin 65,* all available at the FCC's Internet Web site: *http://www.fcc.gov/oet/rfsafety.*

Note to paragraphs (a) through (d): SAR is a measure of the rate of energy absorption due to exposure to RF electromagnetic energy. The SAR limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized SAR in §4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE Std C95.1-1992, copyright 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. The criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," NCRP Report No. 86, §17.4.5, copyright 1986 by NCRP, Bethesda, Maryland 20814. Limits for whole body SAR and peak spatial-average SAR are based on recommendations made in both of these documents. The MPE limits in Table 1 are based generally on criteria published by the NCRP in "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," NCRP Report No. 86, §§17.4.1, 17.4.1.1, 17.4.2 and 17.4.3, copyright 1986 by NCRP, Bethesda, Maryland 20814. In the frequency range from 100 MHz to 1500 MHz, these MPE exposure limits for field strength and power density are also generally based on criteria recommended by the ANSI in §4.1 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE Std C95.1-1992, copyright 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017.

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FCC PT 1.1310 SAR & MPE

(e) Table 1 below sets forth limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*100	6
3.0-30	1842/f	4.89/f	$*900/f^2$	6
30-300	61.4	0.163	1.0	6
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*100	30
1.34-30	824/f	2.19/f	$*180/f^2$	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
1,500-100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

(1) Occupational/controlled exposure limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when a person is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure. The phrase *fully aware* in the context of applying these exposure limits means that an exposed person has received written and/or verbal information fully explaining the potential for RF exposure resulting from his or her employment. With the exception of *transient* persons, this phrase also means that an exposed person has received appropriate training regarding work practices relating to controlling or mitigating his or her exposure. Such training is not required for *transient* persons, but they must receive written and/or verbal information and notification (for example, using signs) concerning their exposure potential and appropriate means available to mitigate their exposure. The phrase *exercise control* means that an exposed person is allowed to and knows how to reduce or avoid exposure by administrative or engineering controls and work practices, such as use of personal protective equipment or time averaging of exposure.

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FCC PT 1.1310 SAR & MPE

(2) General population/uncontrolled exposure limits apply in situations in which the general public may be exposed, or in which persons who are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

(3) Licensees and applicants are responsible for compliance with both the occupational/controlled exposure limits and the general population/uncontrolled exposure limits as they apply to transmitters under their jurisdiction. Licensees and applicants should be aware that the occupational/controlled exposure limits apply especially in situations where workers may have access to areas in very close proximity to antennas and access to the general public may be restricted.

(4) In lieu of evaluation with the general population/uncontrolled exposure limits, amateur licensees authorized under part 97 of this chapter and members of his or her immediate household may be evaluated with respect to the occupational/controlled exposure limits in this section, provided appropriate training and information has been provided to the amateur licensee and members of his/her household. Other nearby persons who are not members of the amateur licensee's household must be evaluated with respect to the general population/uncontrolled exposure limits.

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ANNEX I – MANUFACTURER-PROVIDED INFORMATION

Note: The accuracy and precision of the following information provided by the manufacturer of the equipment under test has not been verified using test methods, cannot be verified, or is not necessary to verify.

MPE Calculations

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RF Maximum Permissible Exposure (MPE)

Exhibit Requirements for Installations in the United States of America

FCC Part 1, Section 1.1307 table 1- Transmitters, Facilities and Operations Subject to Routine Environmental Evaluation states the following for Part 90 Devices:

- Part 90 devices Non-building-mounted antennas: height above ground level to lowest point of antenna <10 m and power >1000 W ERP (1640 W EIRP). Building-mounted antennas: power >1000 W ERP (1640 W EIRP).

Another way of wording this is that Part 90 devices are not Subject to Routine Environmental Evaluation when the antenna is installed at 10Meters or higher and operating total power level of all channels is less than 1640 Watts EIRP.

As an example, a 100W transmitter with a 10dB gain antenna with a low loss cable would translate into 1,000 Watts EIRP in the envelope lobe. If it is mounted 10 Meters or higher above where people could be walking, you have a safe installation and do not have to perform MPE calculations for safe distance.

If the antenna is lower than 10 Meters then you need to verify that your installation is at a safe distance for Exposure to the General Population.

For United States installations, you must ensure that your installation complies with the Maximum Permissible Exposure (MPE) requirements for general population that are specified under FCC Part 1 Section 1.1310 Table 1.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
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3.0-30	1842/f	4.89/f	*900/f^2	6
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300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*100	30
1.34-30	824/f	2.19/f	*180/f^2	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
1,500-100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

- **Power density limit for the band 152 to 174MHz** = 0.2 mW/cm²

MPE and Safe Distance Calculations for USA Installations

This Power Density value is determined by the combination of RF output, cable loss, antenna gain, and distance from the antenna when energized.
The MPE calculation for US installations is expressed as follows:

- **Power Density Pd (mW/cm²) =** $\left(\frac{EIRP}{4*\pi*d^2}\right)$

Where

- **d** = distance from the antenna expressed in cm.
- **EIRP expressed in mW =** $10^{\left(\frac{[Tx\ pwr\ (dBm)+Ant\ Gain\ (dBi)-Cable\ Loss\ (dB)]}{10}\right)}$
- **Tx Power (dBm)** = 10*log[Tx Power (mW)]

As an example, with the transmitter running at 100 watts output into an antenna with a gain of 10 dBi using a short cable with 0dB loss, to verify if 650cm (6.5meters) is a safe distance from the antenna to ensure exposure compliance of 0.2mW/cm2:

1) 100 Watts Tx Power = 50dBm

2) EIRP (mW) = $10^{\left(\frac{[Tx\ pwr\ (50dBm)+Ant\ Gain\ (10dBi)-Cable\ Loss\ (0dB)]}{10}\right)} = 10^{\left(\frac{60}{10}\right)}$ = 1,000,000mW

3) Pd (mW/cm2) = $\left(\frac{\mathrm{EIRP}}{4*\pi*d^2}\right) = \left(\frac{1{,}000{,}000}{4*\pi*650^2}\right) = \left(\frac{1{,}000{,}000}{5{,}309{,}291}\right)$=0.19 mW/cm^2

- 6.5 meters (21.125 Feet) is a safe distance for US installations when using a 10dBi Antenna

The minimum safe distance, from a radiating structure using different "Gain Antennas"

- For the Band 152 to 174MHz with 2dBi Gain Antenna: d (safe distance) = 2.6 m
- For the Band 152 to 174MHz with 6dBi Gain Antenna: d (safe distance) = 4.0 m
- For the Band 152 to 174MHz with 10dBi Gain Antenna: d (safe distance) = 6.5 m

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END OF TEST REPORT

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